

## Strategies for the Treatment of Pancreatic Pseudocysts and Walled-Off Necrosis After Acute Pancreatitis: Surgical Treatment

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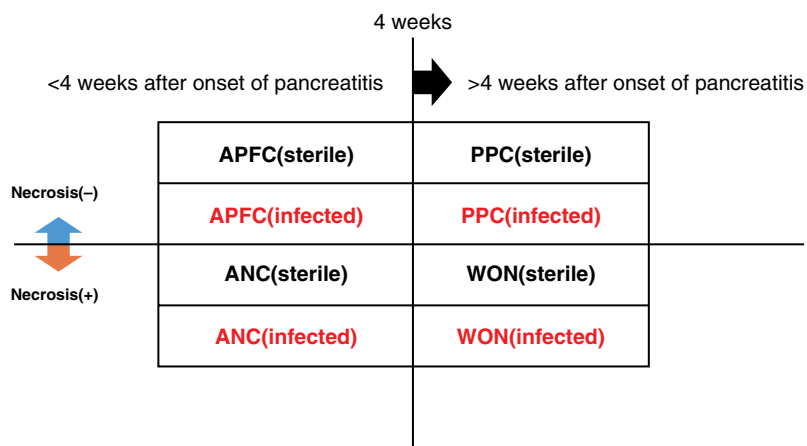
### Introduction

The strategy for surgical intervention in patients with pancreatic pseudocysts (PPC) and walled-off necrosis (WON) has dramatically changed in recent decades and the optimal approach is still controversial. In the early 1980s, open drainage and closed lavage were the most common surgical procedures performed for “pancreatic abscess.” A more aggressive approach resulting in earlier surgical intervention, with more extensive drainage and debridement of associated necrotic tissue has been recommended [1]. However, early intervention including open necrosectomy is associated with poor outcomes and the latest guidelines suggest that surgical intervention should be delayed as long as possible, until at least 4 weeks after the onset of the illness [2,3].

Peripancreatic fluid collections are frequently seen in the management of patients with acute pancreatitis. Acute pancreatitis is divided into interstitial edematous pancreatitis and necrotizing pancreatitis [4]. In interstitial edematous pancreatitis, fluid collections are usually resorbed spontaneously and clinical symptoms are improved after a week. However, remnant localized fluid collections sometimes require intervention in patients with necrotizing pancreatitis. The terminology for these remnant localized fluid collections was completely changed in 2012 by the revised Atlanta classification [4]. This chapter will focus on surgical strategies for the treatment of patients with PPC and WON after episodes of acute pancreatitis.

### Definition of Pancreatic Pseudocyst and Walled-Off Necrosis

In the Atlanta classification, advocated at the International Symposium on Acute Pancreatitis in Atlanta in 1992, acute fluid collections and pancreatic necrosis/infected necrosis were defined as local complications in the early stage of acute pancreatitis [5]. In addition, PPC and pancreatic abscess are also defined as local complications in the late stage. The term “pancreatic pseudocyst” had been used to describe a wide spectrum of fluid collections derived from necrotizing pancreatitis, interstitial edematous pancreatitis, and acute exacerbations of chronic pancreatitis. Capsulized liquefied necrotic pancreatic and/or peripancreatic tissue after necrotizing pancreatitis should be considered different from a capsulized collection of pure pancreatic exocrine secretions. If the same treatment had been performed, the outcome would be different [6,7]. In fact, pancreatic abscess was seldom encountered in either Western countries or East Asia. Based on this background, the concept of “walled-off pancreatic necrosis” was proposed for an encapsulated fluid collection derived from necrotic pancreatic and/or peripancreatic tissue in patients with necrotizing pancreatitis [8]. The term was changed to “walled-off necrosis (WON)” and the concept of this condition was then established by the revised Atlanta classification in 2012 [4] (Fig. 35.1). WON is defined as a mature, encapsulated collection of pancreatic and/or peripancreatic necrosis that has developed a well-defined inflammatory wall and usually occurs more than 4 weeks after the onset of necrotizing pancreatitis [4].



**Figure 35.1** Eight categories of local complications of acute pancreatitis defined by the revised Atlanta classification of 2012. APFC, acute peripancreatic fluid collection; ANC, acute necrotic collection; PPC, pancreatic pseudocyst; WON, walled-off necrosis.

A fluid collection originating from necrosis less than 4 weeks after the onset of necrotizing pancreatitis is referred to as an acute necrotic collection (ANC). The concept of a PPC was proposed to be limited to an encapsulated collection of fluid with a well-defined inflammatory wall, usually outside the pancreas, with minimal or no necrosis that occurs more than 4 weeks after the onset of interstitial edematous pancreatitis [4,9]. As the concept of PPC changed and the new concept of WON was developed in 2012, care must be taken to avoid confusion regarding the terms PPC and WON, especially when reviewing clinical studies reported before 2012.

The International Association of Pancreatology and the American Pancreatic Association (IAP/APA) guidelines were revised according to the revised Atlanta classification of 2012, and the IAP/APA evidence-based guidelines for the management of acute pancreatitis were published in 2013 [2]. At the same time, Japanese guidelines for the management of acute pancreatitis were revised and the fourth edition was published in 2015 [3]. The diagnosis and treatment of acute pancreatitis should be based on these guidelines.

## Indications for Surgical Intervention

Previously, surgical intervention with drainage and necrosectomy was the gold standard for treatment of the infectious complications of acute pancreatitis. In the early 2000s, minimally invasive interventions were developed and have been replacing highly invasive surgical procedures such as open drainage. Minimally invasive interventions include procedures such as endoscopic and laparoscopic drainage and necrosectomy. Both the IAP/APA guideline 2013 and the Japanese guideline 2015 recommend that interventions should be performed in patients with infections or other persistent symptoms, such as ongoing gastric outlet, intestinal, or biliary obstruction, pain, or complications due to a mass effect

secondary to WON or PPC. Most patients with infected localized fluid collections that cannot be managed by the administration of wide-spectrum antibiotics will require some therapeutic intervention.

The terminology for drainage and necrosectomy should be appropriately used. Drainage is a procedure to drain fluid by percutaneous, transgastric, enteral, or transpapillary routes, or by open surgery. Necrosectomy is a procedure to remove necrotic tissue aggressively, using percutaneous, transgastric, or enteral approaches, or by open surgery. Confusion regarding the terminology for drainage and necrosectomy procedures must be considered when evaluating clinical studies reported before 2012.

## Timing of Interventions and Optimal Interventional Strategy for Walled-Off Necrosis

In the past, outcomes following early invasive surgical interventions were very poor [10–12]. In a prospective study of 629 patients, late intervention significantly decreased mortality and morbidity [13]. Both the IAP/APA guideline 2013 and the Japanese guideline 2015 refute the beneficial therapeutic effect of early intervention, and recommend that intervention should be delayed as much as possible, until at least 4 weeks after the onset of pancreatitis [2,3]. Interventions should be performed when fluid collections are encapsulated and the capsule wall is thickened.

The optimal interventional strategy is still controversial. Open surgery was the only choice for intervention before 2000. Minimally invasive interventions, including endoscopic drainage and necrosectomy, and laparoscopic necrosectomy, were introduced in the late 1990s and early 2000s. Though the use of these novel interventions has been increasing, they require advanced technical skills and should be done only in high-volume

centers. Some centers reported good results, although there is a large variance in the expertise in performing these novel interventions among centers. Further assessment is necessary for these interventions to become standard approaches.

The Dutch Pancreatitis Study Group proposed a step-up approach for the treatment of patients with suspected or confirmed infected necrotizing pancreatitis [14]. The step-up approach is composed of two parts, including initial image-guided percutaneous (retroperitoneal) catheter drainage or endoscopic transluminal drainage followed by endoscopic or surgical necrosectomy. Percutaneous catheter drainage alone is reported to reduce the necessity for necrosectomy in 23–50% of patients with infected necrotizing pancreatitis [2,14–19]. Additionally, the step-up approach is reported to decrease major short-term and long-term complications and reduce overall costs compared to conventional surgical necrosectomy [14]. At present, the step-up approach is thought to be the most effective approach and both the IAP/APA guideline 2013 and the Japanese guideline 2015 clearly recommend it as the optimal interventional strategy [2,3]. The IAP/APA guideline 2013 also states that no subgroup of patients requiring a different strategy can be defined, and the optimal method of necrosectomy (i.e., surgical or endoscopic necrosectomy) is unclear if catheter drainage fails [2].

Catheter drainage is always the first step for intervention in patients with local infectious complications of necrotizing pancreatitis. Less-invasive procedures, such as percutaneous drainage by ultrasonography or computed tomography, and endoscopic transluminal drainage are the primary recommendations [13–16] (Fig. 35.2).



**Figure 35.2** Computed tomography scan findings of infected walled-off necrosis on the 170th day after the onset of necrotizing pancreatitis. Air bubbles were observed in the area of walled-off necrosis located in the lesser omentum, which strongly suggests the presence of infection.

Surgical drainage with a small incision is indicated in patients for whom percutaneous or endoscopic approaches are contraindicated or fail. Multiloculated cysts, multiple cysts, presence of significant necrotic debris, cysts in the pancreatic tail, and uncontrolled hemorrhage are also indications for surgical drainage. If catheter drainage fails to control infection, minimally invasive or open surgery or endoscopic transluminal necrosectomy are the next steps.

Laparoscopic and video-assisted retroperitoneal debridement (VARD) have become new choices for a second step intervention [14]. The results from 13 recent series of percutaneous drainage for necrotizing pancreatitis indicate a 26.4% conversion rate from percutaneous drainage to surgical drainage, with a 15.2% mortality rate [14,20–31]. The results from 17 recent series of surgical necrosectomy indicate the need for additional necrosectomy in 16.5%, additional drainage in 13.8%, and an overall 25.8% mortality rate [32–48]. However, the step-up approach has better outcomes. The results from nine recent series report a 17.4% conversion rate to the surgical approach with a 14.9% mortality rate [14,33,49–54]. Bleeding, pancreatic fistula, and gastrointestinal fistula are frequent complications of these interventions.

### Surgical Intervention for PPC

Since acute exacerbations of chronic pancreatitis are a leading cause of PPC, the strategy for the treatment of PPC should be different from that used for WON. Most small PPC spontaneously regress without specific interventions. Evidence of infection or persistent symptoms are a common indication for intervention in patients with PPC (Fig. 35.3). External or internal drainage is the first



**Figure 35.3** Computed tomography scan findings of a pancreatic pseudocyst. The pancreatic pseudocyst resulted from an acute exacerbation of chronic pancreatitis, and is located in the left subphrenic space.

choice for infected PPC, and other novel interventions have been developed and evaluated clinically. Open cyst-enterostomy (i.e., cyst-gastrostomy or cyst-jejunostomy) is often used with a reported 25.4% morbidity and 0.2% mortality in five recent retrospective series [55–59]. Laparoscopic cyst-enterostomy, a minimally invasive approach, is becoming more common and performed by various methods, including a Roux-en-Y anastomosis and intragastric procedures [60–65]. The laparoscopic procedure has good outcomes, with 9.5% morbidity, 3.6% PPC recurrence, and 0% mortality in seven recent series

[60–66]. Percutaneous cyst-gastrostomy, draining the PPC via both percutaneous and transgastric routes with a gastroscopic procedure, is feasible with 11.3% morbidity and 9.4% requiring an additional surgical cyst-gastrostomy [14,67–69]. Bleeding, abdominal abscess including cyst infection, pancreatic fistulas, and surgical site infections are common complications of surgical procedures for PPC [55–66]. Pancreatectomy, distal pancreatectomy, pancreaticoduodenectomy, or duodenum-preserving pancreas head resection are indicated in some patients with a PPC and persistent chronic pain [59].

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